

*Tapes decussatus* L. A distinct species.

*Tapes floridus* Sow. Two examples.

*Venerupis iris* L. A Mediterranean shell.

*Donax trunculus* L.

*Donax vittatus* Lam. Smaller than the former.

*Solen vagina* L. *Ceratisolen legumen* L.

*Mactra corallina* L. Common. *Lutraria elliptica* Lk. Mrs. Whishaw.

*Pholas dactylus* L. Probably will be found living.

*Loripes lactea* L. Single valves. *Divaricella divaricata* L.

*Tellina cumana* Costa. Not uncommon on mud flats.

*Tellina distorta* Poli. Rarely found.

*Tellina planata* L. One specimen.

*Pandora inaequalvis* L. Mrs. Whishaw.

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THE ANATOMICAL STRUCTURE OF CERTAIN EXOTIC NAIADES COMPARED WITH THAT OF THE NORTH AMERICAN FORMS.

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Having studied the anatomy of the soft parts of a large number of North American *Unionidæ*, I published a preliminary account of the results some time ago (NAUTILUS, Feb. 23, '10, p. 114 ff.). This had the effect that several exotic genera were submitted to me for examination, on which I have reported also (*Parreysia*, in NAUTILUS, April 23, '10, p. 139; *Spatha*, *ibid.*, August, '10, p. 39).

The peculiar facts discovered in these shells induced me to select some representative forms out of the large material of South American mussels in possession of the Carnegie Museum, and collected by Mr. J. D. Haseman, since a comparison of these with the others was much needed. A superficial examination revealed at once some very interesting features, and so I made up my mind to condense the chief results in the present paper, and to give the necessary figures to illustrate them.

Of North American types I have used for comparison the genera *Margaritana*, *Quadrula* and *Unio*. *Margaritana* stands by itself, exhibiting some quite unique features. *Quadrula* and *Unio* (together with *Rotundaria* and *Pleurobema*) are the most primitive forms among the rest of the North American *Unionidæ*, constituting my

subfamily *Unioninæ*. The other North American members of the family (*Anodontinæ* and *Lampsilinæ*) may be disregarded, since they are peculiarly developed and specialized, and have no closer relationship with the exotic forms to be discussed here. Of the latter I shall discuss the genera *Parreysia* and *Lamellidens* from Asia (India), *Spatha* from Africa, and *Hyria* and *Tetraplodon* from South America, with a few additional remarks on *Castalina*, *Diplodon*, *Glabaris*, *Fossula* and *Monocondylæa*, also from South America.

#### THE NORTH AMERICAN FORMS.

All North American *Unionidæ*, including *Margaritana*, differ from the African and South American types in two characters, not mentioned by me previously. These are the *anterior attachment of the inner gills* and the *shape of the palpi*. They agree in these with the Asiatic genera. The inner gill decreases perceptibly in width toward its anterior end; the latter is more or less in advance of the anterior end of the outer gill, and it is attached for a longer or shorter distance to the ascending part of the mantle-attachment line, but it is always distinctly separated from the posterior end of the palpi, generally by a considerable interval (see pl. v, figs. 1, 2, 3, 4). Possibly in *Unio* this interval is shortest; in all other forms (also in the *Anodontinæ* and *Lampsilinæ*) it occupies generally the larger portion of the ascending part of the mantle-attachment line. As regards the *shape of the palpi*, this character is not so sharply marked, but in the North American forms they are more or less falcate, with a posteriorly drawn out point. The hind margin of the two palpi may be more or less connected or almost free (compare the same figures on pl. VI).

As to all other characters we are to separate *Margaritana* from the rest of the North American forms, and I have created for it the subfamily *Margaritaninæ*. As I have pointed out in my first paper, the chief differences are found in the conformation of the anal and branchial openings, in that of the posterior end of the diaphragm, and in the finer structure of the gills. In *Margaritana margaritifera* (L.), branchial and anal opening form one large, uninterrupted opening, and there is on the mantle margin no distinct separation of them; the branchial is ill defined anteriorly, its papillæ passing rather far forward on the inner mantle edge and disappearing gradually, and there is no supraanal opening. In fact there is no ten-

dency whatever to unite the edges of the mantle at any point (see pl. VI, fig. 1). The diaphragm is unique in this genus: the outer lamina of the outer gills is posteriorly not connected with the mantle for a considerable distance, in consequence of which the posterior end of the gills (diaphragm) is drawn into a projecting, free point, forming a very incomplete diaphragm between the anal and branchial opening. And finally the gills possess the peculiar feature that they have no water tubes, that is to say the connection between the two laminae is not formed by continuous septa, but by isolated and irregularly scattered subcylindrical projections of the tissue, which sometimes are arranged in indistinct and diagonal rows.

*Unio* and *Quadrula*, on the contrary, show a tendency to more sharply separate branchial and anal opening, and to develop a supra-anal. The diaphragm is formed by the gills, which run backward to or close to the mantle margin, the outer laminae of the outer gills being connected with the mantle to their ends. Thus the edges of the mantle are drawn together at this point, but without growing together, which effects a sharp separation of the anal and branchial opening. Further, the anal is limited above by the coalescence of the inner mantle edges. This junction is rather short, and above it a part of the original anal is left open, the supraanal opening (the genus *Rotundaria* makes an exception, and has an anal like *Margaritana*; also in the subfamily *Lampsilinæ* we have an exception in *Lampsilis parva* (Barn.), where the anal is entirely closed above, at least sometimes). The branchial is better defined in front in these forms by the sudden disappearance of the papillæ of the inner edge.

Finally the structure of the gills is characteristic; here there are well developed water tubes, formed by septa running from base to edge of the gill, generally without any interruption.

*Unio* and *Quadrula* are also characterized by the marsupium (the marsupium of *Margaritana* is unknown). The water tubes (ovisacs) are narrower, and the septa are stronger and closer together than in the non-marsupial gills (see pl. VII, figs. 1 and 2). Either all four of the gills (*Quadrula*, pl. VII, fig. 1) or only the outer ones (*Unio*, pl. VII, fig. 2), in their whole length, are used as marsupium. There are no additional differentiations in the marsupial gills, the gills simply swelling during the period of gravidity, and the edges of the gills do not undergo any change (this is different in the *Anodontinæ* and *Lampsilinæ*).

The larvæ of *Unio* and *Quadrula* are glochidia of simple, semi-circular or semi-elliptical outline, with the anterior and posterior end practically undistinguishable in the shell.

#### ASIATIC FORMS.

*Parreysia wynegungaensis* (Lea) (see NAUTILUS, April, '10, pl. VI, fig. 4, and pl. VII, fig. 3) has essentially the structure of *Quadrula*. The anal and branchial openings, the diaphragm, the palpi, gills and marsupium are practically identical, as is also the general shape and insertion of the gills (the inner separated from the posterior end of the palpi). The only differences are found in the separation of the anal and supraanal, which is somewhat longer, in the attachment of the inner lamina of the inner gills to the abdominal sac, and in shell characters, chief of which is the "radial sculpture."

In addition I have investigated a species of *Lamellidens*, to which I am also indebted to the courtesy of Mr. Frierson.

*Lamellidens consobrinus* (Lea) from India; a sterile female is at hand. This is generally like *Parreysia* in structure, not only in those characters which agree with *Quadrula*, but also in the supra-anal, which is rather widely separated from the anal, and in the inner lamina of the inner gills, which is connected with the abdominal sac.

But there is an important exception; only the *outer gill is marsupial*, and at the posterior end of this gill *there is almost one-fourth of it of non-marsupial structure*.

The septa are of the *Quadrula* and *Unio* type, but in the marsupial part of the outer gill I observe some septa which are not complete (see pl. VII, fig. 4), i. e., they arise from either lamina without meeting in the middle of the interlaminar space; other septa are connected only by their epithelial tissue, but most of them are complete.

Possessing only a single individual, it is impossible to decide whether this is a permanent or temporary structure. It might be that the incomplete septa of the sterile female becomes complete in the gravid female.

In a general way *Lamellidens* has the same relation to *Parreysia* as *Unio* has to *Quadrula*. But it is by no means identical with *Unio*: the structure of the supraanal, the inner lamina of the inner gill and the marsupium separates it sufficiently. It remains to be seen whether the posterior part of the outer gill is always non-marsupial.

The shell of my specimen has nothing remarkable, and there is no sculpture visible near the beaks.

According to the above observations there is no question that both *Parreysia* and *Lamellidens* group with my subfamily *Unioninæ*, but that they differ generically from the North American forms. The investigation of more Asiatic types is very desirable.

#### AFRICAN FORM.

*Spatha kamerunensis* Walker. In NAUTILUS, August 24, '10, p. 39, I have given the description of the soft parts of this species. The chief differences from the North American, and also from the Asiatic, forms are the following (see pl. VI, fig. 5, and pl. VII, fig. 5):

1. The inner gill decreases very little in width in front, and is attached in its whole width to the whole length of the ascending part of the mantle-attachment line, and thus its anterior end comes in contact with the posterior end of the palpi.<sup>1</sup>

2. The palpi are broad and short, with a very insignificant point behind, and not at all falcate; their posterior margins are not connected.

3. The anal and branchial openings are sharply separated by a bridge, formed by the firm union of the mantle edges, which extends somewhat inward, and thus

4. The diaphragm is formed posteriorly by this bridge, and not by the gills, which do not reach the posterior mantle margin.

5. The anal opening is closed above by the union of the inner mantle edges without leaving a supraanal opening.<sup>2</sup>

6. The septa of the well developed water tubes are rather remote from each other and strong.

7. In the female, the inner gills alone are used as marsupium, the septa becoming wider, but not closer set (this structure practically occupies the whole gill).

Larvæ were not found in the specimens at hand.

These differences, pre-eminently 1, 3, 4, and 7, are fundamental,

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<sup>1</sup> The inner lamina of the inner gill is free from the abdominal sac. According to von Ihering (Zool. Anz. 14, '91, p. 479, and 15, '92, p. 2) it should be connected.

<sup>2</sup> The anal opening is continued upward, above the rectum, as a supraanal canal, which ends blindly.

and distinguish *Spatha* at a glance from the North American shells, as well as from the Asiatic *Parreysia* and *Lamellidens*, while, as we shall see by comparison with South American shells, the shape of the palpi, and the special structure of the water tubes is not so important, and while, in the development of the anal and supra-anal opening, there are differences also in the South American shells.

#### SOUTH AMERICAN FORMS.

The following observations are new, and so it seems advisable, to give a more complete description of the structure of the soft parts of some of these forms. I select as the first, and most important, the type-genus of the *Hyriinæ*.

*Hyria corrugata* Lamarck. Two specimens are at hand, both females, the one sterile, the other gravid, with eggs. They have been collected by Mr. J. D. Haseman on Dec. 10, '09, on a sand bar in Rio Tapajos, at Santarem, State of Para, Brazil. (See pl. vii, fig. 6, and pl. vi, fig. 6).

Anal opening closed above by the connection of the inner mantle edges without forming a supraanal opening, closed part about twice as long as the anal opening.<sup>1</sup> Anal opening a little shorter than the branchial opening, separated from the latter by the solid union of the inner mantle edges. Inner edge of anal opening almost smooth, of the branchial opening with small papillæ, which stop suddenly anteriorly, thus marking the anterior boundary of the branchial opening. In front of this the inner mantle edges are smooth and perfectly unconnected. (There is nothing like "short, contractile siphons," as Simpson states on the authority of J. E. Gray, unless it should be that the inner edge of the anal is capable of expansion.)

Palpi longer than wide, not falcate, although slightly produced posteriorly, and bluntly pointed, not connected on the posterior margin.

(To be continued.)

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<sup>1</sup> Under the closed part extends the supraanal canal, exactly as in *Spatha*, although von Ihering asserts (Zool. Anz. 15, '92, p. 2) that in the South American *Unio* (which includes *Hyria*, etc.) there is no such canal, and that the mantle edge is affixed to the adductor muscle. The latter is impossible, since there is the rectum above the adductor.